Unexamined German Patent DE 41 26 774 A1

Converter Arrangement for Receiving Satellite Signals

A converter arrangement for receiving satellite signals has a specific selection of local oscillator frequencies to prevent or reduce the interfering influence of two-fold or three-fold local oscillator frequency differences.

DESCRIPTION

This invention concerns a converter arrangement for receiving satellite signals according to the definition of the species of Claim 1.

Meanwhile, a number of satellites have been placed in geostationary orbits in space, so that a wide variety of programs and program packages can be received via these satellites.

The satellites that have become most important in recent times include Astra 1A, which transmits in a frequency band of 11.2 to 11.45 GHz, for example.

Furthermore, another satellite, Astra IB, has been positioned in a geostationary orbit a slight distance from the former.

Linearly polarized waves perpendicular // orthogonal to one another are transmitted via both signals for reception of a wide variety of television programs, namely channels 1 through 16 over the Astra 1A satellite and channels 17 through 32 over the Astra 1B satellite with the frequency bands shown in the accompanying table, with the transmitted signals in each channel being linearly polarized alternately horizontally first and then linearly and thus being perpendicular to one another.

Since the two Astra satellites are in geostationary orbits in the immediate vicinity of one another, the programs transmitted by the two satellites can be received by just one satellite receiving system.

The horizontally polarized waves of the Astra 1A and Astra 1B satellites can be converted to an intermediate frequency (IF) range by means of a local oscillator in one reception

branch downstream from a polarization filter, e.g., with a local oscillator frequency of 9.7 GHz. In the second reception branch, the vertically polarized waves transmitted over channels 2 through 32 are converted to the corresponding IF frequency band by a local oscillator frequency of 10.25 GHz, for example. This results in two offset frequency bands which can be fed onto a single output line, i.e. a single-cable lead, by using a diplexer. Since the frequency spacing between the horizontally and vertically polarized transmission ranges of the two satellites is large enough, a combination diplexer which does not have a very steep characteristic can be used, thus making it possible to limit manufacturing costs.

However, now a third Astra satellite, Astra 1C, is to be positioned in a geostationary orbit in the immediate vicinity of the two other satellites, with Astra 1C transmitting on channels 33 to 48 with frequencies of 10,964 to 11,185.5 GHz. One result of this is that in the second reception branch, channels 33 through 48 of the Astra 1C satellite are converted by the local oscillator into an IF frequency which partially overlaps with the IF frequency of channels 21 through 31, for example. Another disadvantage is that the frequency shift between the Astra 1C channels and Astra 1B channels is too small or is practically nonexistent, so a combination diplexer would have to meet especially high requirements with regard to the required steepness.

In particular, however, mixed products occur between the two above-mentioned local oscillator frequencies, corresponding to a single or a multiple of the difference between the local oscillator frequencies. Although the first mixed product is outside the received frequency range, the disadvantage of the second mixed product, i.e., twice the frequency difference between the two local oscillators, becomes all the more serious because this

mixed product falls directly in a certain reception channel and thus leads to interference in transmissions sent out over this channel. The same thing applies to higher mixed products.

Therefore, the object of the present invention is to overcome the disadvantages according to the state of the art and create a converter arrangement whereby the programs transmitted at different frequencies can be received with a high quality and with little or very little interference effect at a comparatively low technical expense, in particular after the third Astra satellite is in orbit.

This object is achieved according to the present invention through the features characterized in Claim 1. Advantageous embodiments of this invention are characterized in the subordinate claims.

The present invention guarantees in an especially surprising and skillful manner that the interfering influence of the mixed products leading to interference can be "suppressed" practically without any additional technical measures; furthermore, the local oscillator frequencies for conversion to the intermediate frequency level are selected so that at least two times or three times the local oscillator frequency difference, i.e., the interference product of the second or third order, will fall exactly within the channel frequency spacing between channels 15 and 17 or between channels 16 and 18, which turns out to be a larger spacing in comparison with the other channel frequency spacings. That is because this "sudden large frequency change" results from the distance between the channel frequencies transmitted by the Astra 1A satellite and those from the Astra 1B satellite.

The selection is always such that the mixed product having the greater interfering influence comes to lie at a large,

optimum distance between the two mixed frequencies of the adjacent channels.

The method of achieving the object of the present invention as explained above is applicable essentially regardless of whether channels 1 through 31, for example, are higher or lower in the IF level in comparison with channels 2 through 32.

In another embodiment of this invention, the V channel range and the H channel range within the total allowed IF bandwidth of 950 to 2050 MHz are positioned for reception of the vertically and horizontally polarized signals respectively, so the bandwidth of the channel gap between the two IF channel ranges is at a maximum.

Finally, in a preferred embodiment of this invention, the frequency shift of the middle channel frequencies of the V or H signals transmitted by the third Astra satellite, Astra 1C, can be selected to be so large in comparison with the V and H signals received in the same frequency band, at least in the sense of a compromise solution, that the least possible interference in the transition range of signals received from the third Astra satellite, Astra 1C, of one polarity to the signals of another polarity received by the two other Astra satellites is produced even with a diplexer with a low steepness. A diplexer with a low steepness has a definite cost advantage and can also be implemented more easily from a technical standpoint.

This invention is explained below on the basis of one embodiment, showing in particular:

Figure 1:	a schematic diagram of the basic design of the converter arrangement according to this invention.

Figure 2: a survey of the received channel frequencies and the position of the interfering mixed products.

Figures 3a through 3c: enlarged diagrams from Figure 2 as excerpts.

Figure 4: graphic plots of an optimally selected mixed product.

Figure 1 shows a schematic diagram of a satellite antenna 1 with a downstream converter arrangement 3 and a single lead 5 in the manner of a "single cable solution," emitting any polarization rotators that might be provided or - for reception of circularly polarized waves - optionally any polarization converters, etc. which might be connected upstream. Such measures may be provided as additional measures as needed.

Converter 3, which is shown only in principle, may include, for example, an upstream filter 7 forming part of the converter arrangement, a preamplifier 9, a polarization filter 11 and a mixing stage 15' or 15", each assigned to a local oscillator 17' and 17", in each downstream reception branch 13' and 13", respectively.

For example, another amplifier 19' or 19" and a combination diplexer 21 may also be connected downstream over a mixing stage. The signals received over the two receiving branches 13' and 13" and converted into a respective IF frequency are then amplified by an additional amplifier stage 23, which is optionally also provided, and then supplied over a single lead 5 to the consumers connected to it.

The individual amplifiers, filters, etc., may optionally also be connected externally to the converter arrangement.

In a preferred embodiment, the first local oscillator in the first branch 15' for reception of the horizontally polarized waves is operated for reception of channels 1, 3, 5, ..., 31 at a frequency of 10,259 GHz according to the accompanying table, and the local oscillator for reception of the vertically polarized waves is operated in a second reception branch 15", i.e., for reception of channels 2, 4, 6, ..., 32 at a frequency of 9,665 GHz.

At the selected local oscillator frequencies mentioned above, this means that according to Figure 2, channels 1 through 31 are converted to a lower intermediate frequency, while channels 2 through 32 are converted to a higher intermediate frequency. The accompanying table shows the frequencies transmitted by the three Astra satellites based on their channels 1 through 48 as well as the polarization. According to this, channel 31, for example, is transmitted at a frequency of 11,670.75 MHz. At a local oscillator frequency LO1 of 10,295 GHz, this yields an intermediate frequency (IF) of 1411.75 MHz, as shown for channel 31 in Figure 1. Accordingly, the intermediate frequencies can also be calculated for the other channels.

Channels 1 through 31 in the embodiments shown here serve to receive the horizontally polarized (H-polarized) signals, and channels 2 through 32 serve to receive the vertically polarized (V-polarized) signals.

Figure 2 also shows that there is a channel gap of bandwidth B between channels 31 and 2, and this should be as large as possible, as will be discussed in detail below. However, the size of this interval is limited, because the allowed intermediate frequency band is usually limited to a frequency spectrum of 950 to 2050 MHz. In the selected embodiment, this condition is satisfied because the first channel has an intermediate frequency of 955.25 MHz and channel 32 has an intermediate frequency of 2020.50 MHz.

A simple calculation shows that the frequency spacing of the middle frequency of the individual channels amounts to 29.5 MHz. There is a larger frequency gap of 43.5 MHz only between channels 15 and 17 and between channels 16 and 18. A mixed product of the second or third order can be placed precisely in this gap, usually a mixed product of the second or third order, which also has a greater interfering influence from a quantitative standpoint in accordance with the technology used here. In the embodiment described here, the frequencies F_{LO1} and F_{LO2} have been selected for the frequencies of the first and second local oscillators so that the following mixed products are obtained:

Mixed product of the 1st order:	$1 \times (F_{LO1} - F_{LO2}) = 594$
Mixed product of the 2nd order:	$2 \times (F_{LO1} - F_{LO2}) = 1188$
Mixed product of the 3rd order:	$3 \times (F_{LO1} - F_{LO2}) = 1782$

It can be seen from this that the first mixed product with a frequency of 594 MHz is outside the reception range.

The second mixed product with a frequency of 1188 MHz is between the middle frequencies for channels 15 and 17, which is converted to the intermediate frequencies of 1161.75 MHz and 1205.25 MHz, as shown in principle in Figure 2 and on an enlarged scale in Figure 2a. This yields a minimum frequency shift d_{17} of 17.25 MHz, which means a great improvement in comparison with the state of the art.

The third mixed product falls in the intermediate frequency band where the vertical channels are converted with a local oscillator frequency of 9665 GHz. The third mixed product with 1782 MHz is between channel 16 with 1770.50 MHz and channel 18 with 1814 MHz. The minimum frequency shift relative to the middle frequency thus amounts to d_{16} = 11.50 MHz.

This distance from the middle frequency of the closest transmission channel is less than that in the case of the second mixed product. However the drawing also illustrates the influence of the interference quantity from a quantitative standpoint, showing that the third mixed product also leads only to a slightly lower interference from a quantitative standpoint. In addition, the frequency shift determined above is also fully sufficient for this low interfering influence from a quantitative standpoint.

Thus, channels 34 through 43 of the third Astra satellite, Astra 1C, are converted with the local oscillator selected here to a frequency band that overlaps partially with channels 23 through 31 and to some extent falls in the bandwidth B of the channel gap between V-polarized waves and H-polarized waves.

Then through suitable filter measures, the channels 34 through 40 illustrated in Figure 2 can be suppressed and blanked out for consumer-regulated feed of precisely the desired programs for transmission on specific channels into a single cable.

It can be seen from Figure 3c and the following discussion that an optimum and favorable frequency shift of Astra 1C channels to Astra 1B channels is obtained with the local oscillator frequency selected here.

Thus, for example, channel 31 of the Astra 1B satellite is converted to an intermediate frequency of 1411.75 MHz. Channel 40 of the Astra 1C satellite is converted to an intermediate frequency of 1402.5 MHz. Thus the frequency shift amounts to 9.25 MHz, so the local oscillator combination of 10,259 and 9,665 GHz offers definite advantages.

Through certain technical measures such as filter components, it is also possible to guarantee that, for example, the interfering influence of the second mixed product is lower than the interfering influence of the third mixed product. Then the corresponding local oscillator frequencies would be selected so that the corresponding mixed product of the third order comes to lie in the center as much as possible, e.g., between the frequencies of channels 16 and 18. As in the embodiment described above, a range in which the mixed product of the second or third order lies within a range of

43.5 ÷ 2 ± 7 MHz

will always be preferred here. This means that the mixed products of the second or third order of the local oscillator frequency difference should lie in a range with a width of, for example, ±7 MHz around the middle of half the frequency spacing between channel 15 and channel 17 or between channel 16 and channel 18, preferably a range with a width of ±6 MHz, ±5 MHz, ±4 MHz, ±2 MHz or ±1 MHz. These relationships are illustrated in Figure 3.

Finally, it should also be pointed out that the local oscillators can be selected so that, in deviation from the embodiment according to Figures 2 through 3c, channels 2 through 30 are converted to a lower intermediate frequency, and channels 1 through 31 are converted to a higher intermediate frequency, so the channel sequence comes to be exactly the opposite of that in the embodiment according to Figure 1. In this case, channels 33 through 47 of the third Astra satellite 1C (for receiving the H-polarized signals) would at least partially overlap with the frequency band of channels 26 through 32 of the second Astra satellite 1B for reception of the V-polarized signals, so that the corresponding blanking measures and a corresponding frequency shift should be achieved here.

The values obtained above on the basis of a preferred embodiment shall be given below on the basis of a simple overview which can be used as the basis for selecting different optimum local oscillator frequencies.

Accordingly, the following relationships are obtained (without going into the details of the derivation):

$$F_{LO1} = F_{17} - 2F_{31} + 2F_{40} - d_{17} + 2K \quad (1)$$

$$F_{LO2} = F_{17} - 3F_{31} + 3F_{40} - d_{17} + 3K \quad (2)$$

where

F_i = the respective frequency of channel i of the Astra satellites,

d_{17} = the preselectable frequency spacing of the interfering mixed product from the transmission frequency of channel 17,

K = the center-to-center frequency shift between the H-polarized signals transmitted on channels 17 through 31 relative to the most proximate V-polarized signals of the third Astra satellite with channels 34 through 48.

Through a suitably skilled selection of d_{17} and K, the local oscillator frequencies F_{LO1} and F_{LO2} can now be determined, with the value for d_{17} relative to the frequency of the nearest channel 17 should meet the following condition:

$$(43{,}5 \div 2 + 7)\ \text{MHz} \geq d_{17} \geq (43{,}5 \div 2 - 7)\ \text{MHz} \quad (3)$$

This would yield d_{17} = 21.75 MHz and K = 14.75 MHz, i.e., half of 29.5 MHz, as the most favorable values, i.e., the

center-to-center distance between the frequency of channel 31 and that of channel 40, for example. Thus, the following would be obtained for the local oscillator frequency as a result:

F_{LO1} = 10,263.5
F_{LO2} = 9,677.0

This essentially optimum solution cannot be used in general because with these local oscillator frequencies, the first channel of the intermediate frequency band would yield an intermediate frequency of 948.75 MHz, which would thus be slightly below the lowest allowed intermediate frequency of 950 MHz, which has already been established. Thus, the optimum value can be determined by a slight deviation in the sense of a compromise.

The optimum value as given above may vary somewhat in larger bandwidths. Values where the difference of F_{LO1} ! F_{LO2} as determined from the above-mentioned most optimum values differ and vary by no more than ±10 MHz, in particular no more than ±9 MHz, ±8 MHz, ±7 MHz, ±6 MHz, in particular ±5 MHz, ±4 MHz, ±3 MHz or only ±1 MHz are still favorable.

Only for the sake of thoroughness, it shall be mentioned here that instead of the above-mentioned equations (1) and (2), the equations given below can also be used:

$$F_{LO1} = F_{17} + 2F_2 - 2F_{31} - d_{17} + 2B \qquad (4)$$

$$F_{LO2} = F_{17} + 3F_2 - 3F_{31} - d_{17} + 3B \qquad (5)$$

where:

B = the bandwidth of the channel gap between channels 31 and 2.

Equations (1), (2) and (4) and (5) given above apply to the case when two times the local oscillator difference as the mixed product of the second order occurs between channels 15 and 17. In certain situations, however, the mixed product of the third order may also have a greater interfering influence from a quantitative standpoint than the mixed product of the second order, so then the mixed product of the third order would be placed between channels 16 and 18, so that the frequency spacing d_{16} relative to the adjacent channel 16 (usually closer) would satisfy the condition given in equation (3).

In this case, equations (1), (2) and (4), (5) would be changed only inasmuch as the following quantities

$+d_{16}$ and F_{16}

would have to be used instead of the quantities

$-d_{17}$ and F_{17}

given there. Thus, d_{16} would represent the value of the frequency difference that should be maintained with one of the adjacent channels in any case.

Another modification shall be explained below merely for the sake of thoroughness.

In deviation from the embodiment according to Figure 1, it is also possible for the local oscillator frequencies for the mixers provided in the first and second reception branches to be selected so that the intermediate frequencies of channels 2 through 32 are lower and thus the channel frequencies 1 through 31 in the intermediate frequency band are higher, so they are switched in comparison with the diagram according to Figure 1. Then channels 33 through 47 received from the third Astra

satellite 1C (for reception of the H-polarized signals) by means of the second local oscillator would partially overlap with some channels, usually channels 26 through 32, for reception of the corresponding V-polarized signals.

With this arrangement, depending on which mixed product of the local oscillator frequency has the greater interfering influence from a quantitative standpoint, the corresponding local oscillator frequencies could be selected so that either the mixed product of the second order comes to lie between channels 16 and 18, or the mixed product of the third order comes to lie between channels 15 and 17 - as much in the middle as possible according to the equations given above for 17 and 16. These equations would then be as follows:

$$F_{LO1} = F_{18} - F_{32} + 2F_{39} - d_{18} + 2K \qquad (6)$$

$$F_{LO2} = F_{18} - 3F_{32} + 3F_{39} - d_{18} + 3K \qquad (7).$$

Instead of quantity K for the frequency center offset, the quantity "B" for the bandwidth in the channel gap can also be selected again, so that as an alternative, the equations can be written as follows:

$$F_{LO1} = F_{18} + 2F_{1} - 2F_{32} - d_{18} + 2B \qquad (8)$$

$$F_{LO2} = F_{18} + 3F_{1} - 3F_{32} - d_{18} + 3B \qquad (9)$$

If, in deviation from equations (6) through (9), it should again be true that the second mixed product has a lower interfering influence than the mixed product of the third order, i.e., that three times the local isolator frequency difference now must be placed between channels 15 and 17 (which have a higher frequency than channels 16 and 18), then again instead of the quantities

$-d_{18}$ and F_{13}

the quantities

$+d_{15}$ and F_{15}

must be inserted into equations (6) and (9), where the quantity

d_i

is to satisfy the corresponding equation (3) for the frequency spacing from the nearest channel i.

Table for the channels transmitted by the Astra satellites, the respective channel frequencies and polarities

ASTRA 1A			ASTRA 1B (1/1991)			ASTRA 1C (1992)		
1	11 214,25	H1	17	11 464,25	H1	33	10 964,25	H
2	11 229,00	V2	18	11 479,00	V2	34	10 979,00	V
3	11 243,75	H2	19	11 493,75	H2	35	10 993,75	H
4	11 258,50	V1	20	11 508,50	V1	36	11 008,50	V
5	11 273,25	H1	21	11 523,25	H1	37	11 023,25	H
6	11 288,00	V2	22	11 538,00	V2	38	11 038,00	V
7	11 302,75	H2	23	11 552,75	H2	39	11 052,75	H
8	11 317,50	V1	24	11 567,50	V1	40	11 067,50	V
9	11 332,25	H1	25	11 582,25	H1	41	11 082,25	H
10	11 347,00	V2	26	11 597,00	V2	42	11 097,00	V
11	11 361,75	H2	27	11 611,75	H2	43	11 111,75	H
12	11 376,50	V1	28	11 626,50	V1	44	11 126,50	V
13	11 391,25	H1	29	11 641,25	H1	45	11 141,25	H
14	11 406,00	V2	30	11 656,00	V2	46	11 156,00	V
15	11 420,75	H2	31	11 670,75	H2	47	11 170,75	H
16	11 435,50	V1	32	11 685,50	V1	48	11 185,50	V

CLAIMS

1. A converter arrangement for receiving satellite signals, in particular for receiving the signals transmitted by the Astra 1A, 1B and 1C satellites, with a polarization filter (11) for separating the horizontally polarized H signals from the vertically polarized V signals, each with a mixing stage (15', 15") in each of the two reception branches (13', 13") downstream from the polarization filter (11), each branch having a local oscillator (17', 17") assigned to each mixing stage (15', 15") for converting the received signals into intermediate frequencies (IF), preferably with a combination diplexer (21) for feeding the frequencies converted into the respective intermediate frequency in the two reception branches (15', 15") into a common lead (5), characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} of the two local oscillators are selected so that the two-fold or three-fold mixed product of the local oscillator frequencies (mixed product of the second or third order) lies between channels 15 and 17 or between channels 16 and 18 on the intermediate frequency level in the frequency gap which is enlarged in comparison with the other channel frequency spacings, and it has a minimum spacing of 14.75 MHz relative to the nearest channels.

2. A converter arrangement according to Claim 1, characterized in that the mixed product of the two-fold or three-fold local oscillator frequency difference is located in the enlarged frequency gap between channels 15 and 17 or between channels 16 and 18 which also has a greater interfering influence from a quantitative standpoint.

3. A converter arrangement according to Claim 1 or 2, characterized in that the bandwidth (B) of the channel gap between the channels for receiving V-polarized signals and H-polarized signals in the intermediate frequency band of 950 to 2050 MHz, which is usually allowed, is at its maximum or at least approximately at its maximum in the intermediate frequency level.

4. A converter arrangement according to one of Claims 1 through 3, characterized in that the frequency shift (K) in the IF level is located above a lower minimum limit between the channels for receiving the V-polarized waves of the third Astra satellite (1C) and the nearby H-polarized signals of the first and second Astra satellites (1A, 1B) or the channels for receiving the H-polarized signals of the third Astra satellite (1C) and the nearby V-polarized signals of the first and second Astra satellites (1A, 1B).

5. A converter arrangement according to Claim 4, characterized in that the frequency shift (K) amounts to more than 5 MHz, preferably more than 6, 7, 8, 9, 10, 11, 12, 13, 14 or 14.75 MHz.

6. A converter arrangement according to one of Claims 1 through 5, characterized in that the local oscillator frequencies of F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{17} - 2F_{31} + 2F_{40} - d_{17} + 2K \qquad (1)$$

$$F_{LO2} = F_{17} - 3F_{31} + 3F_{40} - d_{17} + 3K \qquad (2)$$

where:

F_i = the respective frequency of channel i of the Astra satellite,

d_{17} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 17,

K = the center-to-center frequency shift between the H-polarized signals transmitted on channels 17 through 31 relative to the nearest V-polarized signals of the third Astra satellite with channels 34 through 43.

7. A converter arrangement according to one of Claims 1 through 6, characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{17} + 2F_2 - 2F_{31} - d_{17} + 2B \qquad (4)$$

$$F_{LO2} = F_{17} + 3F_2 - 3F_{31} - d_{17} + 3B \qquad (5)$$

where:

F_i = the respective frequency of channel i of the Astra satellites,

d_{17} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 17,

B = the bandwidth of the channel gap between channels 31 and 2.

8. A converter arrangement according to one of Claims 1 through 5, characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{16} - 2F_{31} + 2F_{40} - d_{16} + 2K \qquad (1)$$

$$F_{LO2} = F_{16} - 3F_{31} + 3F_{40} - d_{16} + 3K \quad (2)$$

where:

F_i = the respective frequency of channel i of the Astra satellites,

d_{16} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 16,

K = the center-to-center frequency shift between the signals of the third Astra satellite and the nearby signals of the first and second Astra satellites.

9. A converter arrangement according one of Claims 1 through 5 or 8, characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{16} + 2F_2 - 2F_{31} - d_{16} + 2B \quad (4)$$

$$FL_{02} = F_{16} + 3F_2 - 3F_{31} - d_{16} + 3B \quad (5)$$

where:

F_i = the respective frequency of channel i of the Astra satellites,

d_{16} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 16,

B = the bandwidth of the channel gap between channels 31 and 2.

10. A converter arrangement according to one of Claims 1 through 5, characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{18} - F_{32} + 2F_{39} - d_{18} + 2K \qquad (6)$$

$$F_{LO2} = F_{18} - 3F_{32} + 3F_{39} - d_{18} + 3K \qquad (7)$$

where:

F_i = the respective frequency of channel it of the Astra satellites,

d_{18} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 18,

K = the center-to-center frequency shift between the signals of the third Astra satellite and the nearby signals of the first and second Astra satellites.

11. A converter arrangement according to one of Claims 1 through 5 or 10, characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{18} + 2F_1 - 2F_{32} - d_{18} + 2B \qquad (8)$$

$$F_{LO2} = F_{18} + 3F_1 - 3F_{32} - d_{18} + 3B \qquad (9)$$

where:

F_i = the respective frequency of channel i of the Astra satellites,

d_{13} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 18,

B = the bandwidth of the channel gap between channels 31 and 2.

12. A converter arrangement according to one of Claims 1 through 5, characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{15} - F_{32} + 2F_{39} - d_{15} + 2K \quad (6)$$

$$F_{LO2} = F_{15} - 3F_{32} + 3F_{39} - d_{15} + 3K \quad (7)$$

where:

F_i = the respective frequency of channel i of the Astra satellites,

d_{15} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 15,

K = the center-to-center frequency shift between the signals of the third Astra satellite and the nearby signals of the first and second Astra satellites.

13. A converter arrangement according to one of Claims 1 through 15 or 12, characterized in that the local oscillator frequencies F_{LO1} and F_{LO2} are obtained according to the following equations:

$$F_{LO1} = F_{15} + 2F_1 - 2F_{32} - d_{15} + 2B \quad (8)$$

$$F_{LO2} = F_{15} + 3F_1 - 3F_{32} - d_{15} + 3B \quad (9)$$

where:

F_i = the respective frequency of channel i of the Astra satellites,

d_{15} = the preselectable frequency spacing of the interfering mixed product relative to the transmission frequency of channel 15,

B = the bandwidth of the channel gap between channels 31 and 2.

14. A converter arrangement according to one of Claims 1 through 13, characterized in that the two-fold or three-fold local oscillator difference between channels 15 and 17 or channels 16 and 18 relative to the nearby channel d_i has a spacing of at least 10 MHz, preferably 12, 14, 16, 18, 20 or 21.75 MHZ.

Plus 3 pages of drawings

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Int. Cl.⁵: H 04 B 1/2
Offenlegungstag: 18. Februar

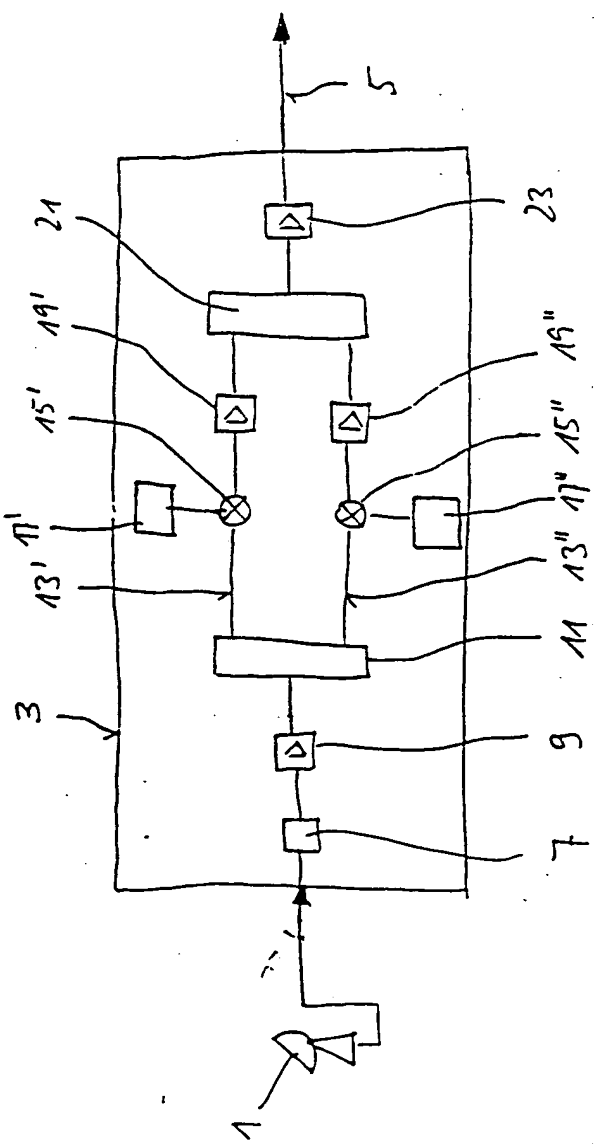
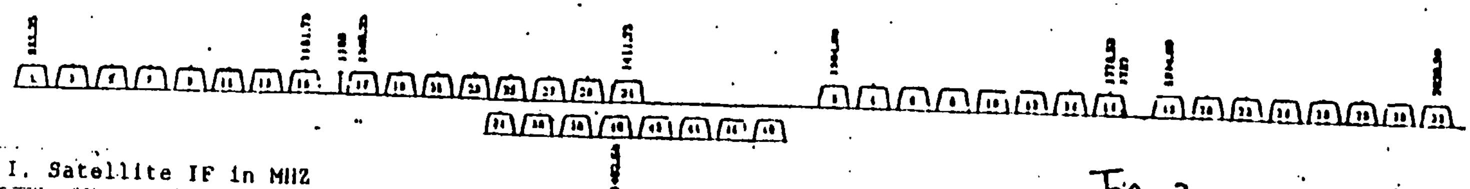


Fig. 1

Nummer: DE 41 28 774
Int. Cl.⁵: H 04 B 1/26
Offenlegungstag: 18. Februar 1

Single-cable solution with LO1 = 10,259 GHz and LO2 = 9,665 GHz



I. Satellite IF in MHZ

Fig. 2

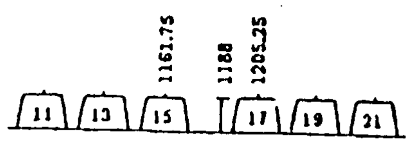


Fig. 3a

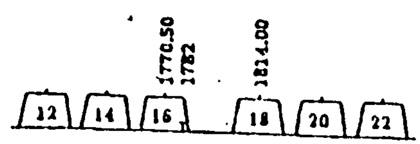


Fig. 3b

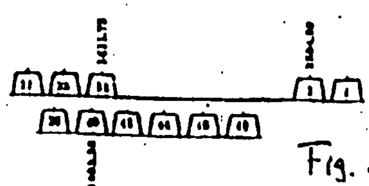


Fig. 3c

Nummer: DE 41 28 774 A1
Int. Cl.⁵: H 04 B 1/26
Offenlegungstag: 18. Februar 1993

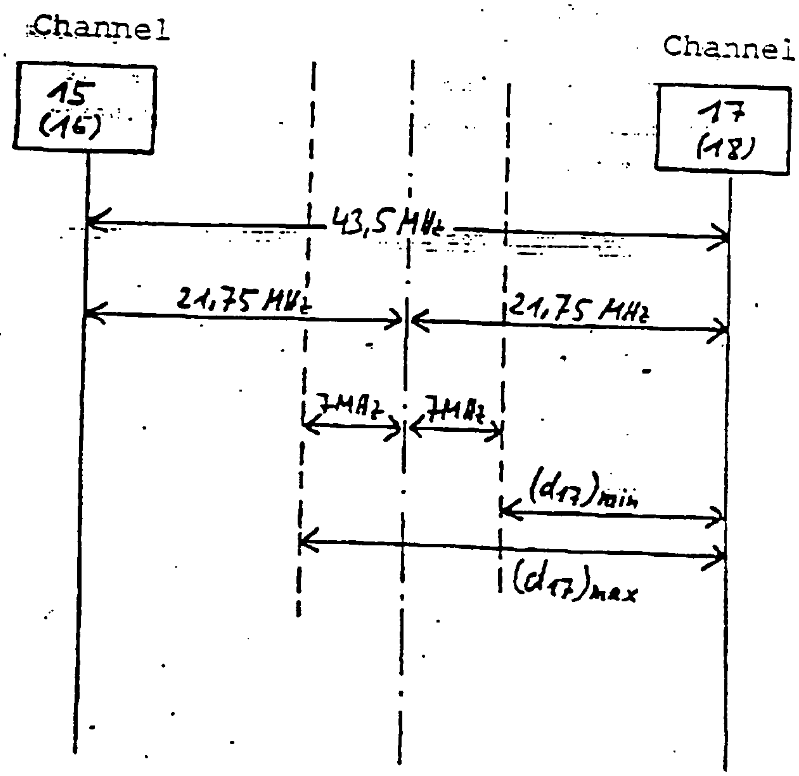


Fig. 4